NOTE ON CERTAIN CLOUD FORMS OBSERVED AT TUCSON, ARIZ., AUGUST 18, 1924

551.576 (791)

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This note describes a certain form of cloud which has been seen a number of times during this unusually dry summer. At first glance this form resembles cirro-stratus, showing up to 5° altitude, long, nearly horizontal lines, occasionally inclined as much as 10° to the horizon. At higher elevations it looks like an etching in white against the otherwise clear blue sky, showing here and there groups of parallel lines or long sinuous curves. On June 3, 1924, near sunset, the crosshatching covered the western sky up to 30° altitude. The lines were a degree or so in width and 10° to 30° long and 2° or 3° apart. An attempt was made to photograph them without success.

On July 11 a similar and more pronounced display was seen near sunset from a moving train some 14 to 20 miles west of Needles, Calif. Again they had the crosshatching effect, covering the western sky up to 40° or 50° altitude. An attempt to photograph them showed only the nearly horizontal strata in the lower 5°. These seemed to me clearly different from cirro-stratus cloud. Their color was different, somewhat less white, and their outlines far softer and no fine detailed structure at all. In this observation some of the larger forms were watched for 15 minutes without important change. They faded away as night came on.

On August 18, at Tucson, a very brilliant display was first noted at 12.30 p. m. covering the western sky up to 30° or 40°. Photographs were taken but are not yet developed. At 1 p. m. the effect had spread over the whole sky, the bands overhead being 8° or 10° wide, perhaps 40° long, and very faint. In the east they were faint and smaller. A whitish haze surrounded the sun. The display lasted till about 5 o'clock. The western lines were horizontal in general effect yet usually in a wavy form like a rope that is thrown into stationary waves or a sine curve projected against the sky. There was a pronounced tendency for these long, soft, rippled lines to come in close pairs. By sighting on strong marks at 7° altitude a motion from near northwest was observed. Their height and real motion seemed worth trying for and were successfully obtained by rapid measures of altitude made at each end of a half-mile measured distance. A full measure consisted of altitudes at one end of the half mile and then the other end and then the first again. The distance was laid off on a straight road running east and west. It took about 10 minutes to get these three readings, and it was found advantageous to leave an observer at the first station, sighting carefully on the cloud form while the trip to and from the other station was being made. This was because continual change in the cloud lines was going on and pronounced forms lasted not much over 10 minutes. Seven measures were made of unequal value. Three good measures on well-defined points at low elevation gave 12,000, 14,000, and 20,000 feet altitude above the ground (elevation of Tucson is 2,400 feet above sea level).

Four poorer measures gave 7,300, 7,700, 10,000, and 28,000 feet. A general average of 15,000 feet or about 3 miles is probably some approximation to their height. Their motion was only a little over 4 miles per hour from north-northwest; this was for most of them a longitudinal motion.

The wind direction on that date was recorded as northwest and that evening a high current from west-northwest to northwest was seen in the big telescope. The attention of a number of townspeople was called to this phenomenon. Some said they had noted it on other occasions this summer. Quite a number of years ago, I observed a single band of this type of cloud moving longitudinally from west to east across the zenith. It was about 5° broad and probably 40° long. It obviously was not ordinary cloud.

Note added October 29, 1924.—Some of my photographs showed the special cloud forms on August 18, but the film had spoiled, and the pictures were not worth printing. I would like to say that since writing that note * * * I have observed the same type of cloud three or four times, and once under such conditions that I could identify them distinctly as a form of stratus cloud formed by the dissipation of cumulus clouds over a large, very dry valley bottom in which there was no irrigation or exposed water of any kind.

The clouds formed in the eastern side of this valley over the Tucson Mountains, 10 miles west of here. There was a slight easterly flow of air and the uprising clouds from that dry valley formed light cumulus clouds, and perhaps as the sun came to the west the upcurrent stopped, and the clouds dissipated along some layer where the motion of air was very slight.

MEETINGS OF THE METEOROLOGICAL SECTION OF THE INTERNATIONAL GEODETIC AND GEOPHYSICAL UNION, SECOND GENERAL ASSEMBLY, MADRID, SPAIN, OCTOBER 1–8, 1924[1]

551.5 (082.2)

By HERBERT H. KIMBALL

[U. S. Weather Bureau, Washington, D. C., December 16, 1924]

SYNOPSIS

The section held sessions for the discussion of its agenda on four half days, and an additional half day was devoted to joint sessions with the sections of Hydrology, Oceanography, and Terrestrial Magnetism and Atmospheric Electricity. The results of the discussions are embodied in a series of 27 resolutions, which may be classified as follows:

(*a*) Resolutions 4, 5, 14, and 15, in which questions were referred to some other organization for action.

(*b*) Resolutions 1, 6, 9, 11, 12, 13, 20, 21, 23, 24, 25, and 27, which express an opinion, or make a recommendation, but do not contemplate action on the part of the section.

(*c*) Resolutions 2, 3, 7, 8, 10, 16, 17, 18, 19, 22 and 26, which call for action on the part of the section.

Under (*a*) the 4 resolutions refer to cloud classification and the measurement of cloud heights; the centralization of meteorological observations made at sea; and trans-Atlantic steamer tracks.

Under (*b*) the 12 resolutions refer to the collection of publications of the Union in designated libraries; the determination of the variability of the hydrogen content of the atmosphere; spectral measurements of solar radiation at Izana, Canary Islands: the extension of radiotelegraphic transmission of meteorological observations; daily observations of temperature and pressure in the free air; an increase in the number of hydrological and meteorological stations in mountainous districts; the simplification of the Gregorian calendar; extension and improvement of the network of stations in the south Pacific; observations of air-borne parasites;

[1] Paper presented before the meeting of the American Meteorological Society, Washington, D. C., January 2, 1925.

and commendatory of the work inaugurated at Teneriffe and on the Jungfrau col.

Under (*c*) the 11 resolutions relate to administrative work of the bureau of the section; sampling the air at great heights; the equipment of additional stations with radiation apparatus; the measurement of the relative brightness of ground and cloud surfaces; illustrations of methods employed in forecasting the weather; cooperation in obtaining sounding balloon observations; atmospheric dust investigations; illustrations of the application of a simplified calendar to meteorological observations; and the compilation of weather charts of the Northern Hemisphere.

NOTES ON THE ASSEMBLY

It will be recalled that the first assembly of the International Geodetic and Geophysical Union was held in Rome, May 1–10, 1922, in connection with the International Astronomical Union. It was the intention to hold triennial meetings of these unions, but so much inconvenience arose from holding simultaneous discussions in different assemblies on subjects of interest to members of both unions that it was decided to separate the meetings of the two. Therefore, the Union of Geodesy and Geophysics fixed the date of its next meeting for 1924, and the Astronomical Union for 1925.

October is a beautiful month in Spain, and especially in Madrid. During the time of the assembly there was practically no rain, the skies were generally clear, and the air had a crispness that was invigorating. The marked temperature changes from day to night were trying to some of the delegates, and bronchial colds became rather prevalent.

The hospitality of the Spanish nation and people was both lavish and hearty, and aided in stimulating a spirit of cooperation among the delegates that contributed materially to the successful solution of questions that arose during the discussion of the agenda of the different sections, and of the union as a whole.

The printed list of delegates contains 132 names, exclusive of the Spanish delegates, representing 31 different countries. It is of interest to note the increase over the Rome meeting in both the number of delegates and in the countries they represented. In the Meteorological Section increased interest was manifest in the discussion of the articles of the agenda. The attempt was made to exclude from the discussions questions primarily relating to administrative matters, and to include only problems relating to the physics of the atmosphere.

All the meetings were held in the Palace of the Chamber of Deputies. There was a commodious assembly room for the plenary meetings of the union, numerous board and committee rooms for the meetings of the sections, a writing room, and a restaurant in which the service was free.

At the inaugural meeting of the union on the morning of October 1, His Majesty the King presided, assisted by representatives of the Spanish Government. An address of welcome to the delegates was made by the chairman of the Spanish committee, Señor Luis Cubillo, which was responded to by the president of the union, M. Ch. Lallemand. Members of the families of delegates attended this meeting. At 6.30 p. m. delegates and their families attended a reception and concert at the Hotel de Ville, where there were more speeches, and delightful sociability.

The morning of October 2 was devoted to a plenary meeting of the union, and in the afternoon the different sections held their first meetings. The meteorological section met with its president, Sir Napier Shaw, in the chair. R. G. K. Lempfert, Esq., of the British Meteorological Office, was appointed temporary assistant to the secretary, Prof. Filippo Eredia. With the exception of the enforced absence of the president at the session of October 4 on account of illness, these officers were present at every meeting of the section. This first meeting was given up to consideration of the report of the executive committee, a summary of which has already been given in the MONTHLY WEATHER REVIEW for July, 1924, **52**: 352–354.

On October 3 the delegates and their families were taken by a special train provided by the Minister of Public Instruction to the city of Toledo for a visit to the Central Seismological Station and to the various public buildings of that ancient city. This again was a pleasant social affair as well as a scientific pilgrimage.

On the morning of October 4 the Meteorological Section commenced the consideration of its agenda. In the absence of the president, the writer of this paper was asked to preside.

In the afternoon delegates and their families were taken in automobiles to visit museums and other points of interest in Madrid. At 10 p. m. they were received in the Royal Palace by the King and his family.

Monday morning, October 6, the Section of Meteorology first held a joint session with the Section of Hydrology, presided over by B. H. Wade, Esq., of Egypt, president of the latter section, and then in succession joint sessions with the sections of Oceanography, and of Terrestrial Magnetism and Atmospheric Electricity, with Sir Napier Shaw presiding.

In the afternoon delegates and their families were taken in automobiles to visit the meteorological and the astronomical observatories, and the Geographical Institute. In the evening they were entertained at a concert in the Royal Theater.

At the morning session of the Meteorological Section on October 7, the consideration of the items of the agenda was completed, and in the afternoon the formal ratification of tentative action on the various items, including the allotment of funds for certain projects, was effected through the adoption of a series of resolutions, which in their final form, after translation from the French, read as follows:

Resolutions adopted by the section of meteorology at the Madrid meetings, October 1–8, 1924:

1. That the union should take steps to obtain from the research council a statement as to the libraries, in the different countries, in which the publications of the union should be assembled, as well as publications received in exchange for those presented to other organizations.

2. (Provides for a card index of names for the regular distribution of the Procés-verbaux.)

3. (Provides for the distribution of notices of prospective meetings.)

4. That the proposal of the national committee of the United States regarding cloud classification (*a*) for scientific study and (*b*) for use in daily weather reports be referred to the International Commission for the Study of Clouds.

5. That the proposal of the national committee of Italy regarding the measurement of the height of clouds be communicated to the International Commission for the Study of Clouds.

6. That the bureau of the section be requested to draw the attention of the Union of Chemistry to the desirability of using cryogenic apparatus for the determination of the amount of hydrogen in the atmosphere from time to time.

7. (*a*) That the national committee of the United States be requested to bring forward details of the proposals for obtaining samples of air from great altitudes.

(*b*) That the attention of the national committee of the United States be drawn to the similar work done by the late M. Teisserenc de Bort.

(*c*) That a sum not exceeding £50 may be appropriated to these observations at the discretion of the executive committee of the Section of Meteorology.

8. That a commission be appointed with a grant of £400 (subject to that sum being available when the final allocation of funds is made) the money to be devoted to the supply of:

(*a*) Instruments (especially self-recording pyrheliometers or pyrgeometers estimated to cost $250 (£55) to be used in (i) Northern Canada or Spitzbergen, (ii) New Zealand or Samoa, (iii) Brazil (Amazon Valley) or Belgian Congo, (iv) the South Orkneys, (Argentine Weather Service) provided that the respective authorities are willing to undertake to use them:

(*b*) Instruments at an estimated cost of £14 10s each according to Mr. Richardson's design, with such modification as may be thought desirable, to four countries which have airplanes at their disposal (France, Great Britain, Italy, United States), after testing the instrument under service conditions.

The following were nominated members of this commission: MM. Kimball (president), Ångström, Gorczyński, Simpson, Platania, Maurain.

9. The Meteorological Section of the International Union of Geodesy and Geophysics expresses the desire that the Meteorological Service of Spain may find opportunity and means to organize at the observatory of Izana in the Canary Islands permanent spectral measurements of the intensity of solar radiation.

10. The Union of Geodesy and Geophysics expresses the wish that the Central Meteorological Service of each country should illustrate by an example the methods on which its forecasts are based. The day selected should be the 25th of September, 1923 (forecasts for the 26th—Cloud Week). Each country should set out the forecasts for its own area but should relate them to the general situation prevailing over the continent to which that area belongs, in such a manner as to bring out the scientific principles on which the forecasts are based. The documents and attached charts should be sent to the secretary of the section for compilation with a view to publication.

It was stated that the French Bureau Central Météorologique was prepared to undertake the publication.

11. The Union of Geodesy and Geophysics expresses the desire that the exchange of observations by radio-telegraphy between North America and Europe should be developed as much as possible and in particular that the United States and France should consider the possibility of transmitting and broadcasting in Europe observations from the Pacific Ocean and from Japan.

12. The Union of Geodesy and Geophysics expresses the wish that the Central Meteorological Services should foster a network of stations for the daily observation of the temperature and pressure in the free air by means of airplanes.

13. The combined sections of Hydrology and Meteorology of the International Union of Geodesy and Geophysics express the wish that the *reseau* of meteorological and hydrological stations in the mountainous districts be increased.

14. The Section of Meteorology has heard the proposals of the Section of Oceanography with great interest and approves cordially the proposal to centralize the collection of observations for limited areas as far as possible. It directs its bureau to take steps to request the International Meteorological Committee to give this question favorable consideration.

15. Without expressing an opinion thereon the section instructs its bureau to take steps to bring the communication of MM. Eredia and Maranello to the notice of the Internatfonal Hydrographic Association.

16. That the bureau of the section be requested to continue its endeavors to obtain observations with *ballons-sondes* and *ballons-pilotes* from the sea and from special regions on land and that the balance of the sum voted in 1922, viz: 25,000 francs capital, 21,200 francs for each of two years, in all 67,400 francs less the expenditure up to date 3,250 francs, 64,150 francs (£750) continue to be at the disposal of the bureau for this purpose as heretofore, for the provision of instruments including the sextant theodolite for use on board ship, provided that any sum granted towards the publication of the results of *ballons-sondes* be included in this grant.

17. That the sum of £500 be allocated to the president in his capacity as president of the International Commission for the Study of the Upper Air in aid of the publication of a year's results of observations of the upper air to be used in addition to any sums that may be contributed for that purpose by countries which do not adhere to the union.

18. That the days selected for the observations of dust in the year 1925 should include international days of the Commission for the Study of the Upper Air.

19. That a small commission be appointed to arrange and advise concerning further investigations [of atmospheric dust] including the relation between dust and visibility and also the potential gradient of atmospheric electricity. Messrs. Owens, Eridia, Angström, Kimball, Jaumotte, were nominated members of the commission.

20. The Section of Meteorology urges the early consideration of the simplification of the Gregorian Calendar by the "Advisory and Technical Committee on Communications and Transit" of the League of Nations and that appropriate steps be taken to bring about international consideration and if possible the adoption of its recommendations.

21. That the section approves and recommends as units of time for meteorological purposes:

(1) The mean solar day.
(2) A week of seven solar days.
(3) A year made up of 51 weeks of 7 days and 1 week of 8 days; but in leap year, 50 weeks of 7 days and 2 weeks of 8 days.
(4) The hour, $\frac{1}{24}$ of the mean solar day.
(5) The second, $\frac{1}{86,400}$ of the mean solar day.

22. That the section invites those who are specially interested in the question to circulate at some convenient time a calendar for the year 1925 showing exactly how they would desire meteorological observations to be dealt with.

23. In view of their great importance for the study of meteorology, the Meteorological Section of the Geophysical and Geodetic Union expresses the hope that steps may be taken by the governments concerned to improve and extend the organization of the network of stations in the south Pacific Ocean and to coordinate the results.

24. The section expresses the desire that the central meteorological services establish a system of observations on air-borne parasites and that these observations be published as widely as possible.

25. The meeting congratulates Señor Galbis on the arrangements that have been made for the study of the physics of the atmosphere at Teneriffe, and looks forward with pleasurable anticipation to the results which will be given to science by that observatory.

26. The section decides to make, as an example and on a precisely limited subject, a test of the services which would be rendered by the International Meteorological Bureau, the organization of which is now being studied by a commission of the International Meteorological Committee.

The problem to be solved, chosen from those which clearly involve international collaboration, is the following:

The compilation of an atlas of daily or bidaily charts covering the greatest possible part of the Northern Hemisphere for the third quarter of the year 1923.

M. La Cour, president of the North Atlantic Chart Commission, will have charge of the execution of the work. He will work under the instruction of a commission including members of the union belonging to the above commission of the international committee. A sum of £500 will be allotted for the work.

27. The section notes with satisfaction that Switzerland has established an observatory on the Jungfrau col, and expresses the hope that it may be actively employed in the international work of meteorology.

Finance.—The following financial statement showing the anticipated income of the section and the proposed allocation of the funds was submitted:

	Expenditure 1922–1924	Proposed expenditure for 1924–1927
	£ sterling	*£ sterling*
Printing and secretarial expenses of the bureau	9	
Capital recurring	70	[1] 105
Composition of the upper atmosphere		50
Exploration of the upper atmosphere, including contribution toward the cost of publication of an international volume of results	60	750
Dust	65	
Solar radiation		400
Daily synoptic charts of as much as possible of the Northern Hemisphere		500
	204	1,805

[1] £ sterling 35 per annum.

PROSPECTIVE INCOME

	£ sterling
Balance in hands of treasurer	308
Balance in hands of general secretary, 29,111 francs	465
Income for 1924	230
Income for 1925, 1926, 1927	697
	1,780

The minutes of the meetings of the section will be published later by the bureau of the section, and in many cases will clarify the meaning of the resolutions.

On the evening of October 7, delegates and their families were entertained by the Spanish committee at a banquet, followed by a concert.

NOTE.—The cost of an international publication of the results for the upper air for one year has been estimated by the Commission for the Study of the Upper Air at £2,000, exclusive of the cost of compilation and reduction.

On the morning of October 8 the final plenary meeting of the union was held for the consideration of questions of interest to the whole union as distinguished from those that pertained to the work of the individual sections only.

Before adjournment it was voted to accept the invitation of the delegates from Czechoslovakia to hold the next assembly of the union in Prague in 1927.

Probably the outstanding accomplishment of the section, the results of which will be awaited with great interest, is the provision in resolution 26 for testing the service that might be rendered by an International Meteorological Bureau. The work of compiling an atlas of weather maps of the Northern Hemisphere, with all possible completeness, for the third quarter of 1923, is a project worthy of international cooperation. However, the discussion as recorded in the minutes shows that grave doubts were entertained by some as to the propriety of "placing money at the disposal of an existing State service for carrying on work of an international character in conjunction with a commission."

Acknowledgment is made of the kindness of Secretary Eredia and Assistant Secretary Lempfert, in placing at the disposal of the author copies of the minutes of the meetings, including the text of the resolutions that were adopted.

AN APPROACH TO RUNOFF EXPECTANCY

626.86

S. L. MOYER, C. E.

[Montevideo, Minn., August, 1924]

The economics of the design of waterways for such purposes as drainage, spillways, bridge and culvert openings, etc., must fundamentally depend upon the frequency with which various run-off magnitudes may be expected.

Comparison of run-off data from different watersheds for any purpose, has very little meaning unless in some way account is taken of this factor of expectancy.

If a series of observations is arranged in the order of magnitude, and the frequency is defined as the interval of time between events of a given or exceeding magnitude, each observation being representative of a given unit of the total period covered equal to the unit in which frequency is measured, then the center of the series has a frequency value of 2 and the maximum observation has a frequency value equal to the total number of observations in the series.

Series frequencies.—From the above facts is deduced the method for determination of the various frequencies outlined as follows.

To determine the frequency for a given observation in a series, arrange and number the observations in the order of their magnitude, then the frequency

$$F=\frac{a}{b-N} \text{ in which}$$

N=the numerical designation of the observation,

$a=T+2\frac{T-1}{T-2}-1$ and $b=T+\frac{T-1}{T-2}$ in which again

T=the total number of observations in the series, each observation representing an interval of time equal to the unit in which the frequency is expressed and

F=frequency or interval of time, in the given unit, between events of a given or exceeding magnitude.

Total number observations in series (T)	$\left(T+2\frac{T-1}{T-2}-1\right)$ (a)	$\left(T+\frac{T-1}{T-2}\right)$ (b)	Total number observations in series (T)	$\left(T+2\frac{T-1}{T-2}-1\right)$ (a)	$\left(T+\frac{T-1}{T-2}\right)$ (b)
5	6.667	6.333	19	20.118	20.059
6	7.500	7.250	20	21.112	21.056
7	8.400	8.200	21	22.106	22.053
8	9.333	9.167	22	23.100	23.050
9	10.286	10.143	23	24.095	24.048
10	11.250	11.125	24	25.090	25.045
11	12.222	12.111	25	26.086	26.043
12	13.200	13.100	26	27.083	27.042
13	14.182	14.091	27	28.080	28.040
14	15.167	15.083	28	29.077	29.038
15	16.153	16.077	29	30.074	30.037
16	17.142	17.071	30	31.071	31.036
17	18.133	18.067	31	32.069	32.034
18	19.125	19.063	32	33.067	33.033
33	34.065	34.032	52	53.040	53.020
34	35.063	35.031	53	54.039	54.020
35	36.061	36.030	54	55.039	55.019
36	37.059	37.029	55	56.038	56.019
37	38.057	38.029	56	57.037	57.019
38	39.055	39.028	57	58.036	58.018
39	40.054	40.027	58	59.036	59.018
40	41.053	41.026	59	60.035	60.018
41	42.051	42.026	60	61.035	61.017
42	43.050	43.025	61	62.034	62.017
43	44.049	44.024	62	63.033	63.017
44	45.048	44.024	63	64.033	64.016
45	46.047	46.023	64	65.032	65.016
46	47.045	47.023	65	66.032	66.016
47	48.044	48.022	66	67.031	67.016
48	49.044	49.022	67	68.031	68.015
49	50.043	50.021	68	69.030	69.015
50	51.042	51.021	69	70.030	70.015
51	52.041	52.020	70	71.029	71.015

After finding the frequency for each observation, the series may be plotted against various functions of the frequency until some function is discovered which causes the observations so plotted to approximate a straight line, and the function so determined is determinate of the relation of magnitude to frequency for the series under consideration.

Annual peak flows so plotted for a number of streams suggest that, for the more frequent events at least, peak flows on any stream tend to approximate a straight line when plotted against

$$\left(\frac{1}{2F}+\frac{4{\cdot}5}{F+8}\right) \text{ in which } F=\text{frequency.}$$

A chart for ready determination of the various values produced by this expression is given in Figure 1.

Designating this expression as d, these same plottings seem to indicate that peak flows for any stream follow a law expressed by a formula of the form of

$$Q=(c-d)e$$

$$\text{in which } d=\left(\frac{1}{2F}+\frac{4{\cdot}5}{F+8}\right),$$

Q=magnitude of flow,

F=frequency or interval in years between peak flows of a given or exceeding magnitude,

ce=limit which magnitude approaches.

By plotting the discharges from various watersheds against d, it is possible to compare any number of records on a basis which gives rational weight to the length of the record and by computing and charting d for various values of F it is possible to construct a frequency scale conforming to this straight line relation, thus affording